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ABSTRACT

The relationship between treatment levels and errors of estimate for a dependent variable in a behavioral science research experiment is typically evaluated by an analysis of covariance. The same relation can be expressed by part correlation. In non-experimental research with individual-difference variables, an assumption regarding independence, as required by analysis of covariance, would be appropriate in the non-experimental situation. (Author/MV)

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Part and Partial Correlation in Psychological Research

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The analysis of covariance is often used correctly and without controversy in experimental behavioral research, where subjects are assigned randomly to treatments and the adjusting variable is employed to reduce the size of errors that are associated with differences among subjects. In the analysis, the dependent variable is adjusted for preliminary differences among subjects after which the relation between the adjusted variable and the treatment variable is evaluated.

In a certain kind of non-experimental research, the use of analysis of covariance has been controversial, if not incorrect. An example is a study involving the comparison of two populations or, more specifically, the comparison of the adjusted means of two samples from different populations.

The example might be construed as involving three individual-difference variables: a dichotomous classification, population membership, and two behavioral variables. Relations among these three variables might be expressed by a variety of correlation statistics, depending on the researcher's interest. However, in the

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questionable covariance analysis, the classification was used as would be a set of treatments in an experiment, one of the behavioral variables was used as would be an adjusting variable, and the other was used as would be a dependent variable.

The product-moment coefficient of correlation is sometimes given special names to identify formulas that may be useful in special circumstances. It may be called "point-biserial" when one of the two variables is dichotomous and the other is not. "Phi coefficient" is the term sometimes used when both variables are dichotomous. "Partial correlation" refers to the correlation between two sets of errors of estimate with one or more common predictors or secondary variables. Not as familiar is the "part correlation coefficient," which relates an unmodified variable and a set of errors of estimate. For both partial and part correlation the order of the coefficient is given by the number of secondary variables. "Multiple correlation" may be defined as the zero-order correlation between a criterion variable and values of the criterion predicted from two or more other variables.

In the experimental covariance analysis, the relation between treatments and differences among adjusted means has a correlation analog. The analog is seldom made explicit. For two treatments, either levels or qualities, the analog is part correlation or, more specifically, point-biserial part correlation. For three or more levels, the analog is simply part correlation. For three or more qualities of treatment there is no correlation analog.

There is a familiar test of significance for the zero-order product-moment coefficient, which uses either t or F and is based on (N-2) degrees of freedom, where N is the number of pairs of scores. The test is also applicable to the partial coefficient, based on (N - 2 - k) degrees of freedom where k is the order of the coefficient or the number of secondary variables. The present authors do not know of a test specifically applicable to the part correlation. However, if the unmodified variable and the secondary variable(s) are independent, as would be the case in an experiment where the unmodified variable would be the treatment variable and the secondary variable would be the adjusting variable, then the part correlation could be tested in a variance ratio as a comparison of treatment and error analogous to the main test of a covariance analysis.

Thus one can speak of part correlation as the correlation analog for the treatment variance or the difference between adjusted means in the analysis of covariance applied to experimental data. It should be noted that the treatment variable(s) and the adjusting variable are assumed to be independent in the covariance model. The operational guarantee of independence is the random assignment of subjects to treatments. The same assumption would apply to the correlation analog. Since treatment effects and pre-experimental differences among subjects are independent, the variability predicted from the adjusting variable and removed in the adjustment will not contain any treatment variability.

In the non-experimental situation mentioned earlier as an example of questionable usage, there are three individual difference variables: population membership and two behavioral variables. None of the three variables is necessarily independent of either of the others and there is no operational guarantee that it will be so. Thus the covariance model does not, in general, fit the situation. Either part or partial correlation might be employed. However, neither is widely used, perhaps because there is relatively little interest in the questions that can be answered by these methods. Clearly it would not be correct to ask and try to answer a question concerning the effects of "treatment." However questions concerning prediction would be appropriate. Any one of the three variables could conceivably be taken as the criterion, with the other two serving as predictors. Usually, however, the behavioral variable that is mistakenly used as a dependent variable is the logical choice as a criterion. The effectiveness of the joint prediction would be given by the multiple correlation coefficient or its square. If the predictive relation between population membership and criterion errors of estimate is, in fact, of interest to the researcher, then the partial coefficient would be a better choice than part because of the somewhat better prediction achieved when population membership and the predictor are not independent.

Given an experiment with three or more levels of treatment, an analysis of covariance would have two or more correlation analogs: the linear correlation between levels of treatment and errors of

estimate for the dependent variable; the linear correlation between errors of estimate and a quadratic function of levels; and so on for cubic and quartic functions, etc., if there are four or more levels of treatment.

Given a classification of three or more qualitative categories, whether experimental or not, there would be no correlation analogs.

In summary, analysis of covariance, applied to an experimental design with two qualities or any number of levels of treatment, has its correlation analog, part correlation. Since subjects are randomly assigned to treatments, the unmodified (treatment) variable and the secondary (adjusting) variable are independent. However, there are multivariate studies to which part, partial, and multiple correlation are applicable but analysis of covariance is not.